2. A ground snow load of 30 PSF, which translates to 18 PSF on an elevated suspension bridge.
3. A 50-year 70 MPH wind on the profile cross-section of the bridge.
4. The span-sag-elevation of the bridge provides a 6.68-foot freeboard to the historical 100-year floodwater elevation of 400 feet for Pochuck Creek at the bridge center and 4.5 feet at the platforms.
5. Allowable soil bearing capacity of 500 PSF.
6. Wire rope safety factor of 4.5.
7. Soil power installed screw anchor safety factor of 3.

Design and Construction of the Bridge Towers

The design of the bridge towers required answers to a number of philosophical and practical questions. The first question was whether the towers should consist of a large number of lightweight structural members (like a "stickbuilt" framed house) or a few massive members (like a log cabin). The original design for the Pochuck Quagmire Bridge consisted of framed, built-up towers consisting of dimension CCA .60 southern yellow pine. This was a design necessity at the time because all material would have had to be hand-carried to the site, assembly would be done by layperson volunteers, and the total budget was $10,000.

This design premise was modified when GPU Energy joined the project as a volunteer. GPU Energy offered to provide, transport, install, and guy 40-foot tall #1 SYP transmission poles to serve as the catenary cable towers. Mr. John Karcher, a professional engineer with GPU Energy, provided technical literature on GPU Energy material and procedures.

The use of round non-uniform transmission poles for the primary structural members of the towers set a certain standard or premise for the project. Heavy timber connections are difficult to make efficiently, particularly when the connection is between a round pole and flat dimension lumber. It is similar to installing a square peg in a round hole. There is very little direct bearing between the two surfaces. The single curve spike grids do assist in addressing this problem. However, the problem in this project was compounded by the fact that the tower joint connections would be made in a remote field location, installed with hand tools, 34 feet in the air, accompanied by friendly mosquitoes. These practical considerations dictated that while the towers are H-Frame, X-braced structures (indeterminate), no allowance would be made for the benefits of the truss construction. The joints are the weak link. The design premise for the towers is that they are designed as simple tapered columns restrained at the base and braced at the top. The Euler effective length of the tower columns was taken as the distance between the top of the foundation and the upper guylines. The intermediate timber cross-members will act to reduce the effective length and increase the load-bearing capacity. But discounting the benefits of these intermediate members and designing the towers as a simple column resulted in a more conservative design.

The design of the towers was a several step process. The following steps were performed:

1. Identify the basic dimensions and geometry of the bridge. Span and the width of the walkway needed to meet the ADA code. These dimensions in concert with a live load of 60 PSF and a snow load of 18 PSF determine the total live load.
2. Design of the walkway structure, i.e., the ribs, chords, diagonals, joists, rails, and decking. The specific design and material used identified the dead load.

3. Identify hydrodynamic and wind loads.
4. Determine the design tension of the wire rope at the midpoint and the cable saddles by analyzing the distribution of the total design load via the suspension system and the sag-span ratio of the wire rope.
5. Utilize design procedures as specified in the "Design Manual for High Voltage Transmission Lines" Rural Electrification Administration (REA) Bulletin 62-1, Department of Agriculture. The Class I SYP transmission poles were checked to determine the maximum safe vertical load against buckling. While using this reference may seem odd at first, one will quickly recognize that transmission lines are "suspension structures." The REA manual presents the practical experience accrued from millions of miles of transmission lines. The REA procedure indicated that the poles discounting the structural benefits of intermediate cross-members could support 42,600 pounds with a safety factor of 3. This is 1.9 times the design load of 22,000 pounds.
6. Utilize design procedures for tapered poles as specified in Section 5 of the "Timber Construction Manual" 3rd edition, AITC. This is a more detailed design procedure than the REA methods. This incorporated the following elements:
   - Adjustments for taper
   - Identification of slenderness ratio and column classification
   - Euler formula for ultimate buckling strength
   - Live load duration modification factor
   - Allowable bending stress of 1,700 PSI (pounds per square inch)
   - Allowable compression parallel to the grain of 900 PSI
   - Modulus of elasticity of 1.5 million PSI

The AITC design procedure identified the allowable axial load on the poles as 32,500 pounds, or 1.48 times the design load of 22,000 pounds.

This six-step procedure resulted in the pole towers detailed on Plan Sheet 4 and Figure 3 on the following page.

Tower Installation

The photographs on pages 20 and 21 provide a pictorial of the tower installation. The extremely poor subsurface conditions required an extensive foundation system. The connection between the towers and the foundation required the poles to be in their final upright position prior to the foundation construction. This required the tower poles to be installed first on a temporary basis with braces and guylines. The foundation, which will be reviewed at length on pages 23-39, was installed immediately afterwards.

As indicated in the photographs, the first step was to auger holes for the poles. The poles were embedded in the soil a minimum of 6 feet for structural and safety purposes. This is common practice for 40-foot poles. Although the ground elevation varied from pole location to pole location by as much as 15 inches, it was important that all four pole tops be at the same elevation. Elevation benchmarks and a surveyors level were used to identify the embedment depth for each pole to ensure a common top elevation to the extent practical. The poles were winched up as shown in photos 2 and 3. Note that the top guyline cable bands were installed before the poles went up. The Chance® Power Installed Screw Anchors (PISA®) for the guylines were also installed before the poles went up. The pole bases were backfilled and tamped. As shown in photos 4 to 9,